Unit Plan Cover Page

Name of Unit: Biological Macromolecules
Grade Level: 9th grade
Length of Unit: Two weeks
Context – This unit is designed for two periods of ninth grade Biology. Period 2 has 35 students, 10 of whom are categorized as English language learners. Two of those English language learners are new arrivals with no previous schooling. 15 of the students in Period 2 have an IEP. Period 3 has 35 students, and none of them are categorized as English language learners. 10 students in Period 3 have an IEP. This unit provides a wide range of experiences, from literacy focused lessons to lab-based inquiry lessons. It gives students the chemical foundation of biology on a small scale so that, in later units, they can understand the underlying processes of biological concepts on a larger scale.

Unit Summary: This unit covers the four major biological macromolecules: carbohydrates, lipids, proteins, and nucleic acids. It contains one model eliciting activity, two 5E inquiry lessons, and two direct instruction lessons (one is a Universal Design for Learning lesson that is literacy focused, the other is the unit's assessment). Each lesson is 3D in that it includes the Next Generation Science Standard covered and that standard's components - science and engineering practices, disciplinary core content, and crosscutting concepts. The lessons in this unit are designed to be student-centered with a focus on small group instruction. They provide hands-on opportunities for students to engage critically with the content covered.

Essential Question: How are structure and function related in biology?
NGSS Standard: HS-LS1-6. Construct and revise an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/or other large carbon-based molecules.

What key knowledge and skills will students acquire as a result of this unit?

Crosscutting Concepts	Systems and System Models, Energy and Matter
Disciplinary Core Content	Organization for Matter and Energy Flow in Organisms
Science & Engineering Practices	Scientific Knowledge Is Open to Revision in Light of New Evidence, Developing and Using Models, Scientific Investigations Use a Variety of Methods
Academic Language	Monomer, polymer, protein, enzyme, lipid, saccharide, carbohydrate, nucleic acid, x-ray crystallography

Topical Questions	Who discovered DNA? What is the precise effect of pH on enzyme activity? What are the four major biological macromolecules made of? How does our body synthesize them?

Assessment

Measurable Objective		**How will the objective be measured? (Formative Assessment)**
Lesson #1 **Enzyme Action**	Students conduct a virtual experiment using lactase and accurately describe and graph their findings to investigate the effects of substrate concentration and pH on enzyme activity.	Students turn in a lab report at the end of the lesson.
Lesson #2 **Lipid Saturation**	Students argue the validity of their model construction of saturated and unsaturated fatty acids by testing their model against two given structural parameters.	Students turn in their models at the end of the lesson.
Lesson #3 **DNA Discovery**	Students discuss the context of historical scientific discoveries by reflecting on the discovery of the structure of DNA in a graphic organizer and sharing their opinions with their classmates.	Students also turn in their graphic organizer at the end of the lesson.
Lesson #4 **Macromolecule Menu**	Students build an argument to justify their choice of food for their school lunch by constructing at least one logically sound claim evidence reasoning passage to explain one of their choices.	Students turn in their menu at the end of the lesson.
Lesson #5 **Macromolecule Showcase** Students describe the structure and function of the four major biological macromolecules by designing a poster containing at least two pieces of accurate information about each. **Overall Summative Assessment:** After giving an overview of the general information provided in the macromolecule unit and previous lessons, the students will receive instructions to create a poster showcasing the information they've gathered. They will work in partners and have two class periods to complete the poster, after which it will be graded in class in small groups.		

Materials and Resources Needed to Complete Unit	
Printed materials	Enzyme Action Lab Report, Lipid Saturation Graphic Organizer, Macromolecule Menu Graphic Organizer, Macromolecule Showcase Instructions, DNA Discovery Article, DNA Discovery Graphic Organizer
Supplies	Large sticky sheets, post-its, pens/pencils, physical molecule models (optional)
Technology	Chromebooks
Resources	None

Differentiation	(Content, Process, Product)
English Language Learner	All small groups can be mindfully made to ensure bilingual peers are present and heterogeneous student populations, individual instruction can be given during independent work time, visual aids are available for all lessons
GATE	Articles for summarizing have been included in every lesson for those that finish early. Students can receive extra credit for these article summaries
IEP/504	All lessons can be completed at home as none of them require materials that are only available during class time. Extra time can be given on all assignments that can not be completed during class. Individual instruction can be given during independent work time.

Reflection

I'm proud of the fact that this unit incorporates so many different styles of lesson and I think that it will be fun for students to experience. I'm excited to teach it! One aspect that I regret is that I'm not able to teach this unit in its entirety yet, as in my practicum classroom we are already well past it in our curriculum. I think that further reflection will be necessary after teaching it, as there are details that only become apparent when trying to implement something for the first time. I am proud of my growth in terms of writing lessons, as I started out struggling a bit with how to put my ideas to paper in ways that were measurable. I think every educator is swarming with ideas for how to create a fun and educational experience, but the logistics of measuring if we've achieved what we set out to achieve are where some may struggle. I used an instructional rubric to grade my final summative assessment, as I believe that rubrics give students the most agency in their learning. As Andrade states in her article *Using Rubrics to Promote Thinking and Learning* in Educational Leadership, "blurring the distinction between instruction and assessment through the use of rubrics has a powerful effect on your teaching and, in turn, on your students' learning." Rubrics allow students to assess themselves as they go, because they know exactly what I'll be looking for and what resources they have available to achieve it. I believe through the use of rubrics and authentic assessments, my measurable objectives for this unit are specific and detailed, and I would feel confident taking this unit into my classroom.

Ms. Webb/9th grade/2019	**Enzyme Action Virtual Lab Inquiry Lesson**	Mon/Tues of week 1 in two week Biological Macromolecules unit

Brief Lesson Description: Students investigate the effects of substrate concentration and pH on enzyme action after a brief presentation on enzymes and their functions using a virtual lab provided by Pearson. Students will generate a hypothesis and then test that hypothesis using the virtual lab. Students will record their data on a graphic organizer provided.

Measurable Objective: Students conduct a virtual experiment using lactase and accurately describe and graph their findings to investigate the effects of substrate concentration and pH on enzyme activity.

Materials: Chromebooks, lab report, slide presentation, pens/pencils

Differentiation Strategies:
ELL – During the inquiry portion, individual attention can be given to students requiring guidance. Students can also work in partners with a bilingual peer.
IEP – During the inquiry portion, individual attention can be given to students requiring guidance. Since this is a virtual lab, students may also complete anything they did not finish in class at home or during lunch.
GATE – Students may read this article (US News "*Connecting Enzymes and Diseases*") and summarize the key ideas for extra credit if they finish the lab report early.

Prior Student Knowledge: This lesson serves as an introduction to enzymes, so students require an understanding that enzymes are proteins, that proteins are made of amino acid monomers, and that protein structure has several layers that serve to specify its function.

NGSS Standard: HS-LS1-6. Construct and revise an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/or other large carbon-based molecules.

Science & Engineering Practices: Developing and Using Models	*Disciplinary Core Content:* Organization for Matter and Energy Flow in Organisms	*Crosscutting Concepts:* Energy and Matter

Possible Misconceptions: Students may have issues with the concept of activation energy, and how enzymes increase the rate of a reaction. Students may also have issues with rejecting their hypotheses or feel averse to being wrong.

Safety Precautions: None.

Engagement (20 min)

The instructor starts by showing a slide presentation that describes the basic functions of enzymes in order to familiarize students on the topic. The students then watch a short video to recap what they've learned. The students take notes during this short presentation, and the instructor introduces the topic of inquiry for the lesson: the effects of changes in pH on enzyme activity.

Exploration (15 min)

Students grab Chromebooks while the instructor hands out the lab report. The students can access the virtual lab at this link: tiny.cc/enzymeslab. They start by investigating the options on the lab and answering a few short questions pertaining to the slide presentation. Students may work in groups of 3-4 for this lab, but must turn in individual lab reports.

Explanation (25 min)

Once students have started the experiment, the instructor can walk around to each group and ensure they are recording their data and that they've set up the experiment correctly. The instructor also checks their hypotheses to ensure that they've generated one and answer any questions students have about their lab reports.

Elaboration (25 min)

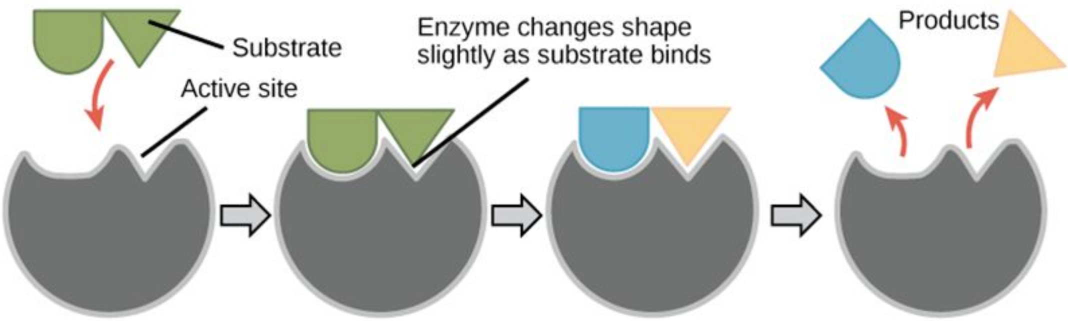
Once most students have finished collecting data, the instructor walks around and checks with each group about the status of their hypothesis. Did they support their hypothesis, and why or why not? The instructors goes through their explanations for accuracy with them and answers any questions they may have.

Evaluation (15 min)

At the end of the lab, the instructor calls on a few groups to share about their hypotheses and why they supported or rejected them. Students turn in their lab reports once they have finished the virtual lab, and it is graded by the instructor as their formative assessment for the lesson.

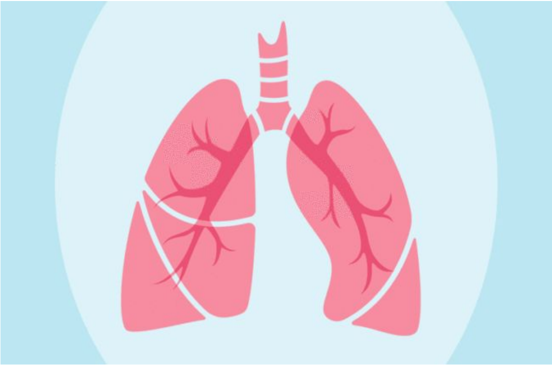
Enzyme Action

Essential question: What are enzymes, and how do they function?



Chemical reactions are happening in your body all the time.

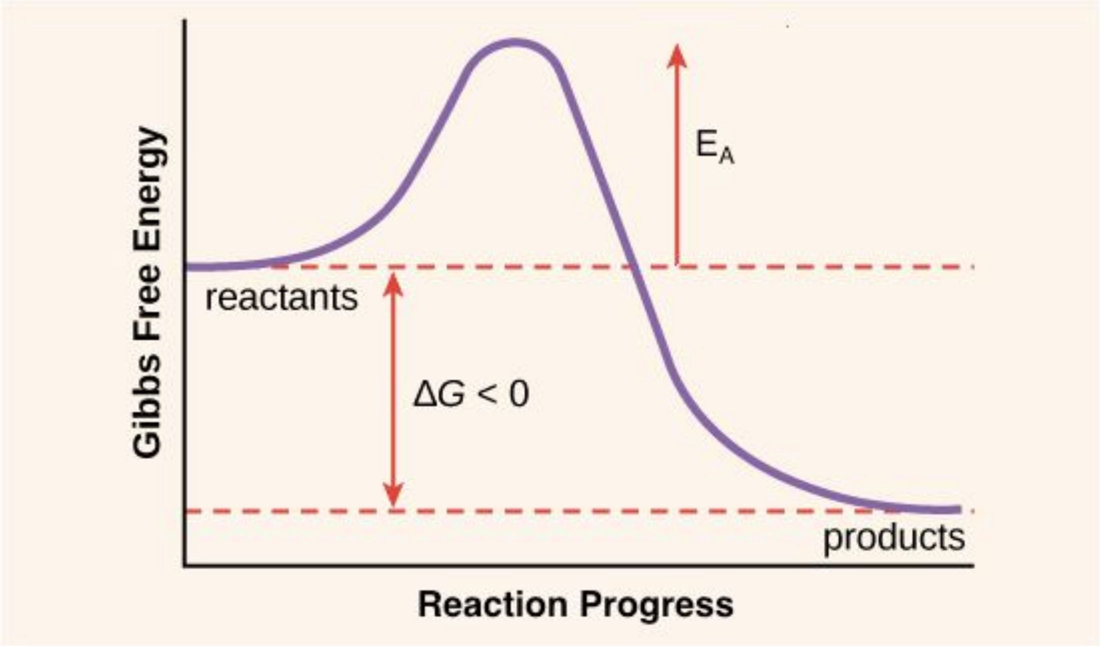
Ex: Breaking down food, cellular respiration, building proteins



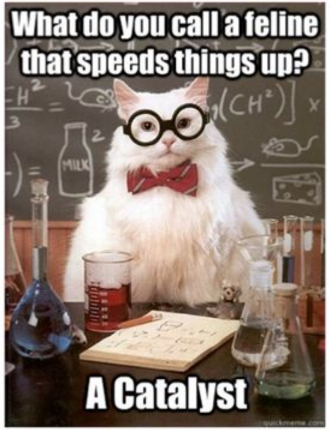
These reactions require energy.

We need a source of energy to efficiently carry out these reactions in our bodies.

The energy that is needed to get a reaction started is called activation energy.

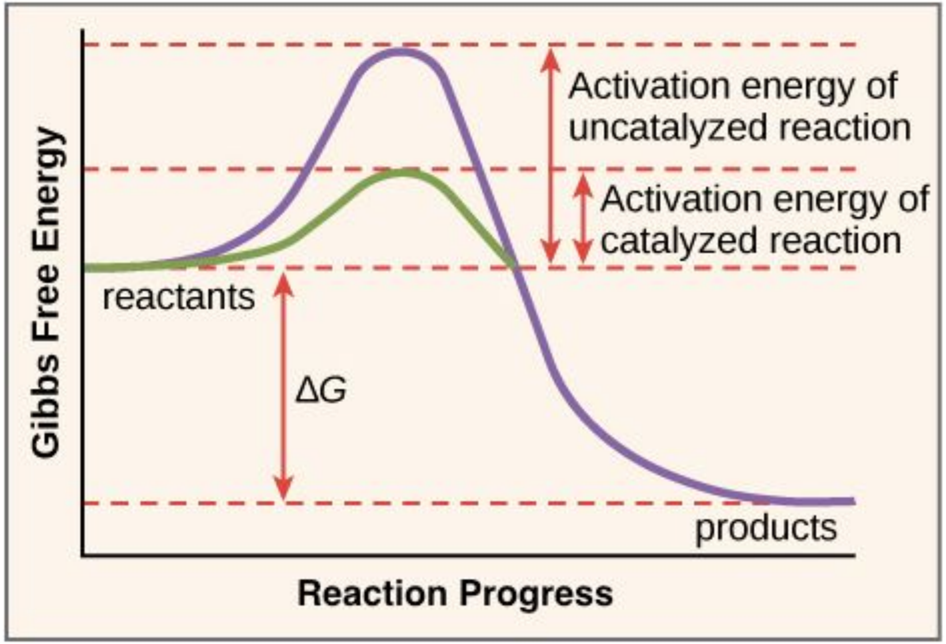


A catalyst is an enzyme that speeds up the rate of a chemical reaction.



Our cells use catalysts to make chemical reactions happen.

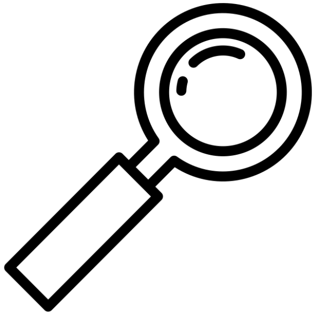
Enzymes are <u>proteins</u> that act as biological catalysts. They <u>speed up chemical reactions</u> that take place in our cells. Enzymes <u>lower the activation energy</u> for a reaction.



Enzymes generally end in the suffix -ase

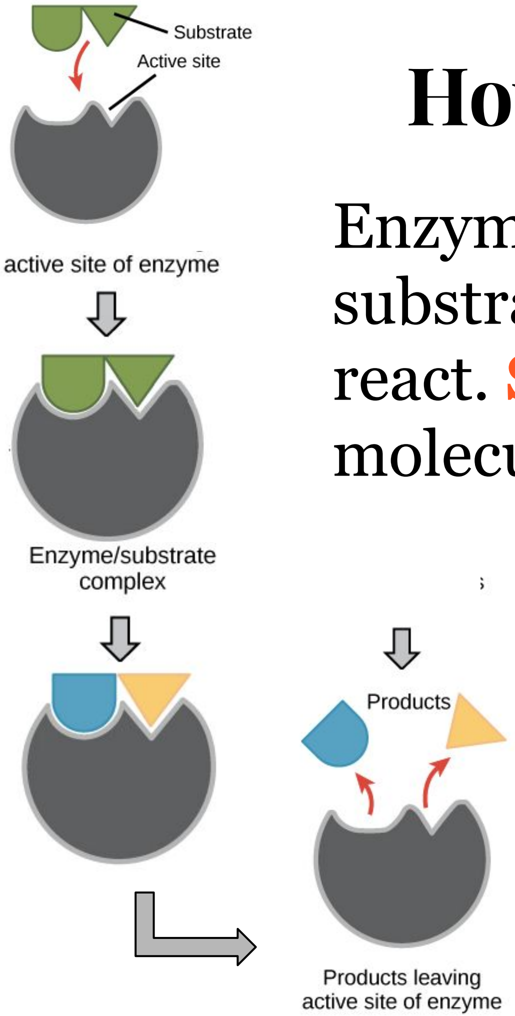
Examples in our bodies:

- *Helicase* - unravels DNA helix during replication
- *Amylase* - in our saliva, breaks down starch
- *Lipase* - breaks down fat molecules in our digestive tract

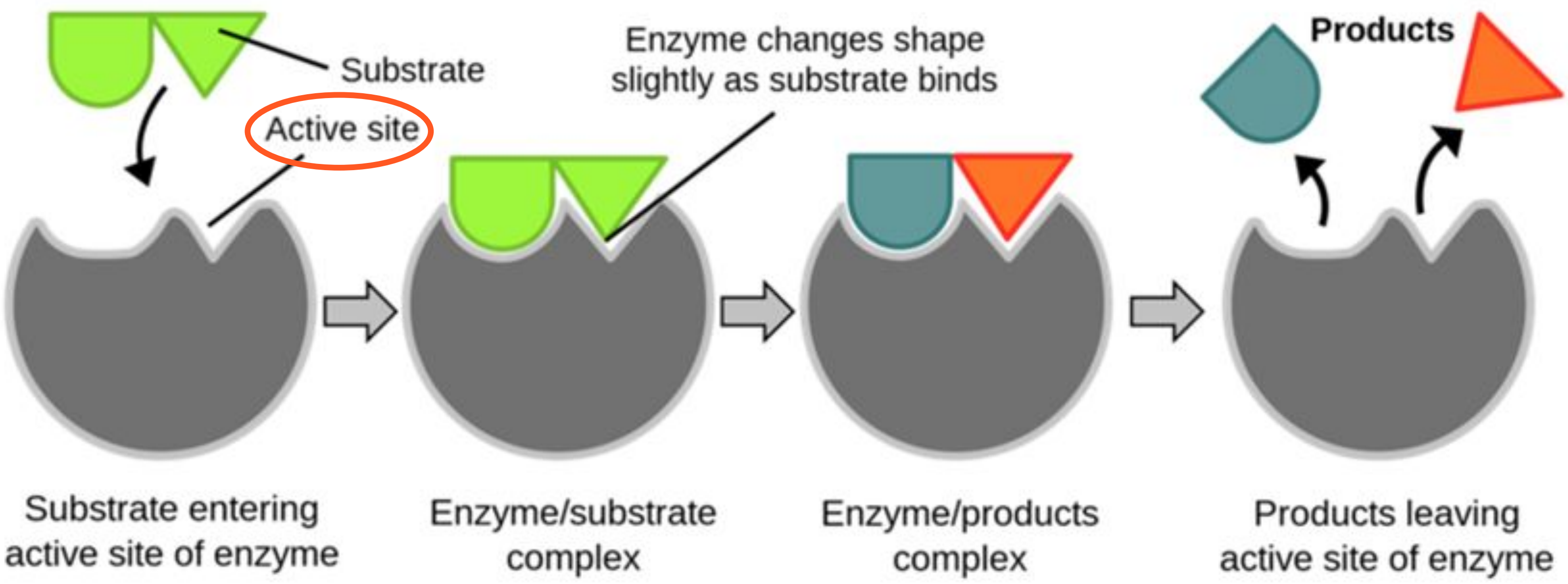


How do enzymes work?

Enzymes provide a place where substrates can be brought together to react. **Substrates** are the reactants molecules enzymes act on.

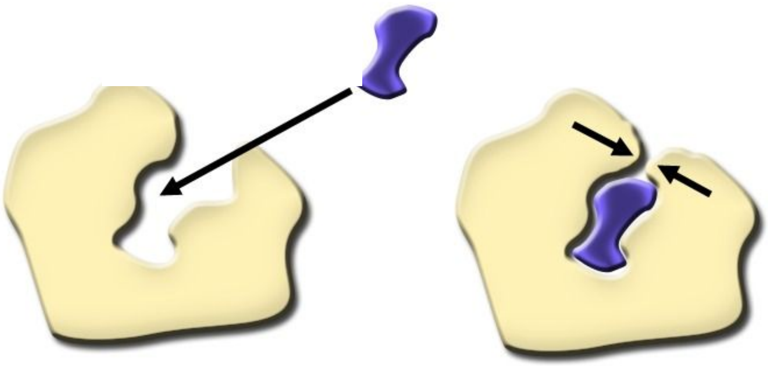


The location where the substrate binds to the enzyme is called the active site.



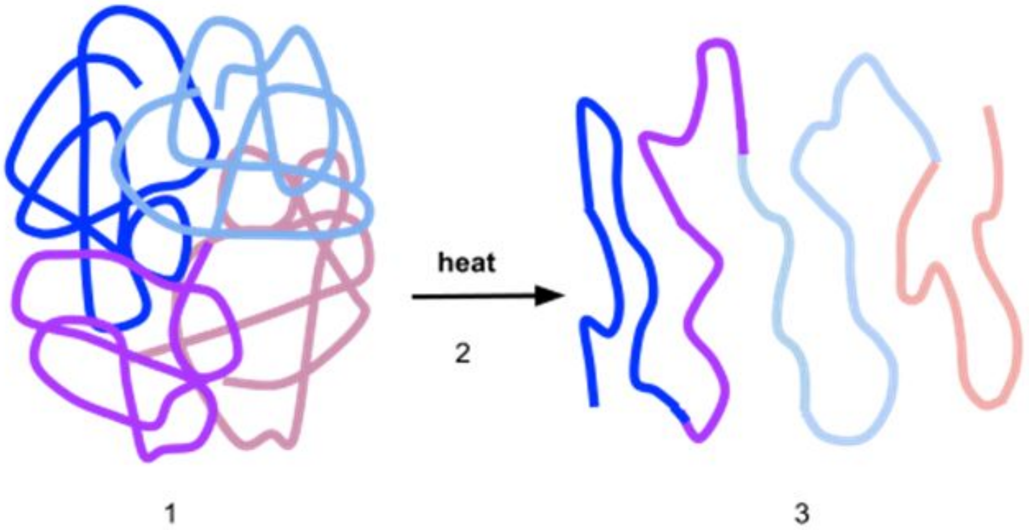
The shape of a protein is important!

Enzymes are generally specific to one substrate. They come together in a process called **induced fit**, where the once the enzyme and substrate meet, they change shape slightly to fit better together.



How does temperature and pH actually affect the enzyme?

Heat and chemicals break bonds between the amino acids and cause the protein to change shape. When the enzyme changes shape and no longer works it is called **denaturation.**



Enzyme Recap:

How does denaturation affect enzyme activity?

What factors do you think influence an enzyme's optimal pH?

Visit tiny.cc/enzymeslab for today's activity. We are going to investigate the effects of pH on enzyme activity.

Name: _____________
Period: _____________
Date: _____________

Enzyme Action Lab Report

Visit *tiny.cc/enzymeslab* to access the virtual lab.

1) Summarize, using your notes, the function of enzymes in our bodies. Make sure to include the following vocab: catalyst, activation energy, induced fit, substrate, active site, enzyme

2) Hypothesize on the effects of temperature and pH on enzyme activity below.
   a) I believe that changes in pH will _______________ enzyme activity.
   b) I believe that changes in substrate concentration will _____________________ enzyme activity.

Follow the instructions in the "Question" column to test your hypotheses. You're going to test each lactose sample at all pH levels: 3, 5, 7, 9, and 11. Record your data in the table below.

Table 1: Record your data on the number of product molecules formed per minute obtained from the virtual lab.

 # Product Molecules/minute at:

Amount of Substrate (Lactose)	pH 3	pH 5	pH 7	pH 9	pH 11
0.5 g					
1.0 g					
2.0 g					
4.0 g					
8.0 g					

3) What substrate amount was required to achieve the maximum reaction rate? How do you know?

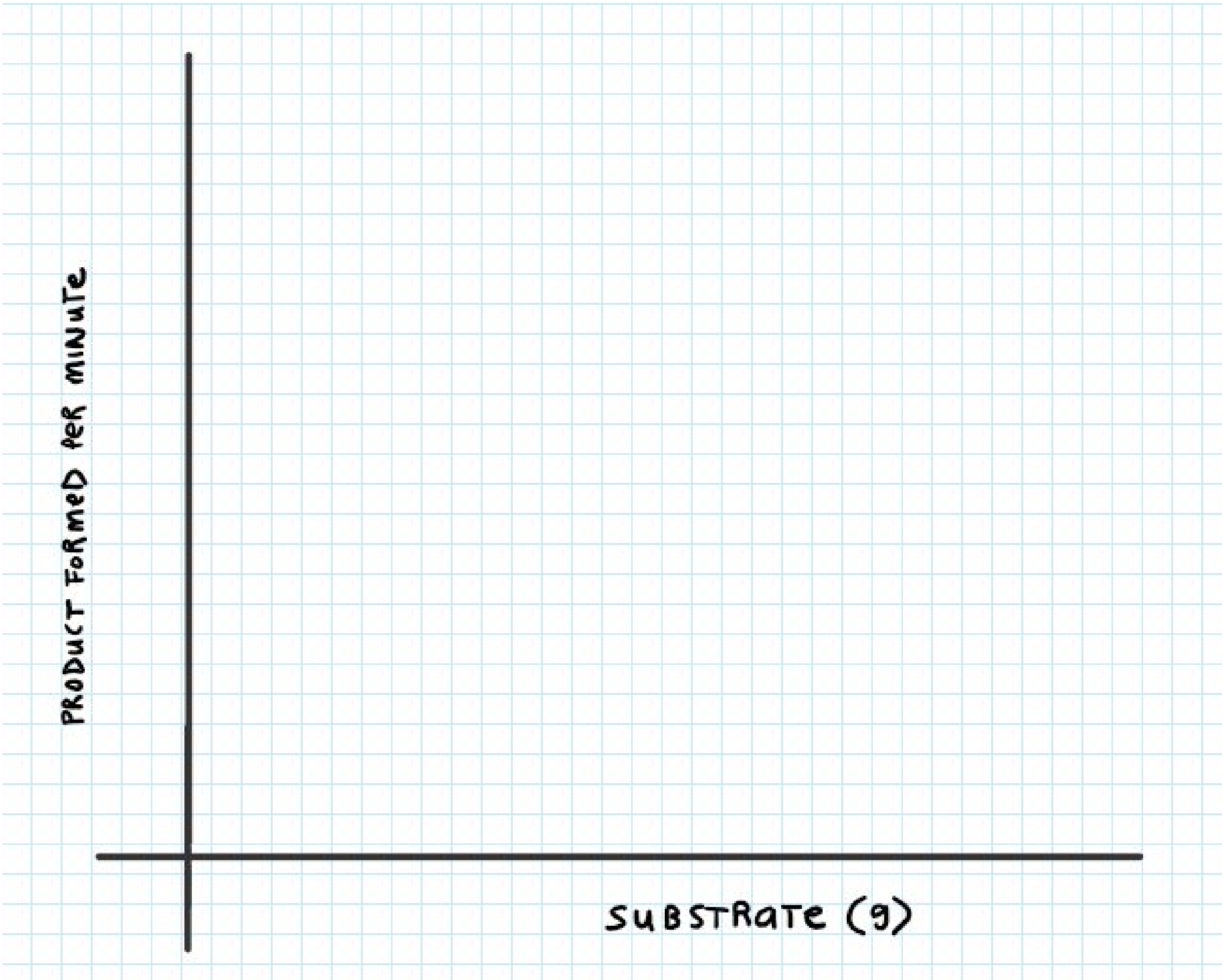
4) At what pH level did the maximum reaction rate occur?____________________

5) Why was there no increase in the reaction rate with 8.0 g of substance as compared to 4.0 g of substance? What would you need to add to see an increase in the reaction rate with 8.0 g of substance?

6) Was your hypothesis regarding substrate concentration and enzyme activity supported? Why or why not?

Make sure to enter you data in the data table provided in the virtual lab as well as on this lab report! You will graph your data in the virtual lab and on this lab report on the following page.

After you have completed your table in the virtual lab, click "Graph" to see a graph of your data. Please draw your graph in the space provided below. Make sure to include labels for your data.



7) In the graph you created in the lab simulation with your data:
   a) What is represented by the green line? ___________________________
   b) What is the optimal pH for lactase enzyme activity? _________________

8) Was your hypothesis regarding enzymes and pH supported? Why or why not?

9) Consider only the experiment you conducted with 0.5 g of lactose.
   a) What is the independent variable? ______________________________

   b) What is the dependent variable? _______________________________

10) The maximum rate of this reaction is 350 molecules product/minute. List two changes you could make in the experimental conditions or variables that would increase this reaction rate. Explain why each change you listed would increase the reaction rate.

Lipid Saturation Activity MEA Lesson Plan

Summary	
Grade Level	9th
Description	Students generate and then test a model of saturated and unsaturated fats using molview in order to illustrate the relationship between the structure of lipid molecules and their functions.
Subject	Biology
Instructional Time	55 min
Keywords	Unsaturated fat, saturated fat, single bond, double bond, lipid, carbon, hydrogen, oxygen
Materials List	Chromebook, pen, graphic organizer, molecular models (physical or digital)

Measurable Objective

Students argue the validity of their model construction of saturated and unsaturated fatty acids by testing their model against two given structural parameters.

Related Standards

HS-LS1-6. Construct and revise an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/or other large carbon-based molecules.		
Science & Engineering Practices: Developing and Using Models	*Disciplinary Core Ideas:* Organization for Matter and Energy Flow in Organisms	*Crosscutting Concepts:* Energy and Matter

Essential Question

How are structure and function related in biology?

Prior Knowledge

Students must be able to:
- put together atoms to form molecules
- understand the difference between single and double bonds
- use basic English writing/reading skills
- use the computer program molview.org in order to construct the models if physical models are not available

Implementation

<u>Intro (5 min):</u> warm up question, "What is the difference between butter and oil? What kind of macromolecule are they?" Answer: butter is a solid, oil is a liquid. You will all act as investigators as to why that is in today's activity.
<u>Lipid Saturation Activity (45 min):</u> Students get their chromebooks. The instructor passes out the lipid saturation graphic organizer and go over the instructions. The instructor walks around and ensures that every student can access the website. After everybody is on the website securely, the instructor lets them work independently for 15 minutes before walking around and asking guiding questions and giving help. The activity can be divided into two sections:
Constructing the Model - students build and draw their version of an unsaturated and saturated fat. They answer questions about their model such as, "What makes your model saturated?" in order to facilitate deeper thinking about their choices. The instructor walks around and checks that they've completed their models as well as asks guiding questions.
Testing the Model - students are given a new piece of data about fatty acids (that saturated fatty acids contain no double bonds and that unsaturated fatty acids contain at least one double bond), and examine their model to see if it fits with the new data.
Accepting or Rejecting the Model - They either <u>accept or reject the validity of their model</u> based on this new data. If they reject their model, they modify their model accordingly so that it is valid with the new data. This involves adding or taking away double bonds from their model. This section should be checked for each student by the instructor.
<u>Closure (5 min):</u> The instructor asks the students to elaborate on the warm up question given the new information they've learned about the structure of lipids. The students do a think-pair-share before turning in their completed graphic organizer.

Assessment

Formative Assessment	The instructor will walk around and assess students in small groups in the middle of the activity using guiding questions. The warm up the following day will be "Did you accept or reject your model of saturated and unsaturated fatty acids? Why?" with a think-pair-share class discussion to follow. This allows them to discuss why their model was accepted or rejected with their peers. The students will turn in their graphic organizer that includes diagrams of their models. This graphic organizer will act as the assessment for the lesson. The graphic organizer contains drawings of their model as well as detailed reasoning behind their acceptance or rejection of their model. It also contains drawings of their modified model if they rejected it.
Summative Assessment	None

Accomodations

If students are unable to construct the molecule from scratch, a backbone can be given to guide them. The hydrocarbon tails and the presence of single or double bonds between the carbons is the key takeaway from the lesson. Visual aids can be used throughout the lesson and individual help will be given from instructor for those struggling. Students with IEPs can be given extra time to complete the organizer, and all parts of the lesson can be accessed from home. For students who finish early, an added discussion of nutrition and why saturated fats are considered unhealthy can be had for extra credit. Students can read this article (Harvard Health, "*The truth about fats: the good, the bad, and in-between*") and write a summary to turn in for extra points.

Name: __________
Period: __________
Date: __________

What makes a fatty acid saturated or unsaturated?

Visit the website ***molview.org*** and try building a fatty acid molecule. Fatty acids consist of these elements: C, H, and O. Try to put these elements together to create a saturated fatty acid in a way that makes sense to you according to these properties:

- Fatty acids consist of long chains of carbon (C) and hydrogen (H)
- Each carbon (C) can only have 4 bonds
- Each hydrogen (H) can only have 1 bond
- Each oxygen (O) can only have 2 bonds
- It should be hydrophobic

It does not have to be completely accurate! It is just your best guess.

Draw a picture of your model of a saturated fatty acid below:

Answer the following questions about your model:

1. What makes your model saturated?

2. What makes your model hydrophobic?

3. Would you say that your model could 'stack' well? If we put many of them together in a container, would they fit together nicely?

4. Does your model have any double bonds between carbon atoms?

Now we are going to try building a model of an unsaturated fatty acid on *molview.org* using the same criteria from the first model.

Draw a picture of your model of an unsaturated fatty acid here:

Answer the following questions about your model:

1. What makes your model unsaturated?

2. Would you say that your model could 'stack' well? If you put many of them together in a container, would they fit together nicely?

3. Does your model have any double bonds between carbon atoms?

Butter is a good example of a compound containing fatty acids. **Why do you think butter is solid at room temperature?** (Hint: think about how the molecules 'stack' together)

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Olive oil is another good example of a compound containing fatty acids. **Why do you think olive oil is liquid at room temperature?**

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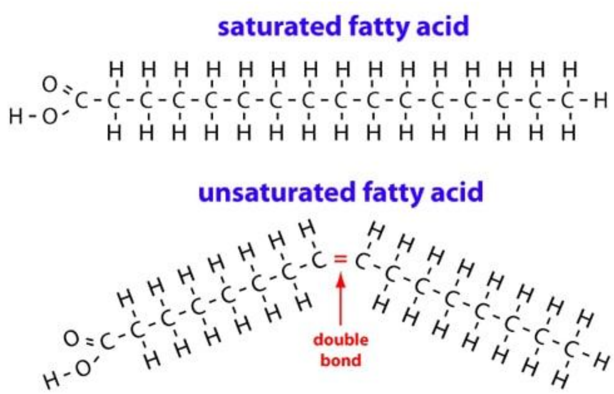


<u>'Stackability'</u> refers to the ability of fatty acids to fit together with very little space between them when stacked.
<u>A molecule is considered stackable if it only has single bonds between the carbons.</u> A good analogy is Legos - the reason Legos stack so well is because they fit together in a way that leaves very little space between them.

Now it is time to test our model! Consider the diagram of saturated and unsaturated fatty acids above and this new data:

Saturated fatty acids are always <u>solid at room temperature, with no double bonds between the carbons</u>. Does your model for a saturated fatty acid fit with this new data? ____________

What changes could you make in order to make your model more accurate?

If you made a new model, draw a picture of it here:

Unsaturated fatty acids are always liquid at room temperature, with at least one double bond between the carbons. Does your model for an unsaturated fatty acid fit with this new data?

What changes could you make in order to make your model more accurate?

If you made a new model, draw a picture of it here:

DNA Discovery Close Reading
Designed By: Corinne Webb, 2019

Class Analysis
Grade Level: 9th Grade
Subject: Biology

Learners	Levels/Assets	Interests/Strengths	Needs: EL (CELDT/ELPAC), IEP, 504, GATE
This lesson is designed for two periods of ninth grade Biology. Period 2 has 35 students, 10 of whom are categorized as English language learners. Two of those English language learners are new arrivals with no previous schooling. 15 of the students in Period 2 have an IEP. Period 3 has 35 students, and none of them are categorized as English language learners. 10 students in Period 3 have an IEP.	Because these students are all ninth graders, we don't have much data on their reading levels. However, during previous reading lessons, the students have struggled with organization and comprehension. Part of the objective with this lesson is to assess their abilities with regards to literacy focused assignments.	The students in Period 2 have developed a strong sense of community within their groups and seem to prefer small group instruction to whole class. Period 3 has developed a strong whole-class community and they enjoy whole class discussions, and are much more willing to share in those environments.	Period 2 is a designated ELL class, so many of those students are English language learners and two of them are new arrivals with traumatic migration experiences. Period 3 is a more typical intro Biology classroom with varying levels and 10 students with IEPs.

Support People	Technology	Supplemental Materials	Resources
This lesson is designed for small group instruction with a whole-class activity at the end.	Chromebooks, students' smartphones	DNA Discovery article, graphic organizer, pen, chromebook, large sticky sheets, post-its, markers	This video about Rosalind Franklin delves further into her role and mistreatment during the discovery, this article in Nature for GATE students

Place in Unit: Tues/Wed of week 1 in two week Biological Macromolecules Unit		
Measurable Objective: Students discuss the context of historical scientific discoveries by reflecting on the discovery of the structure of DNA in a graphic organizer and sharing at least one of their opinions with their classmates in a gallery walk.		
NGSS Standard: HS-LS1-6. Construct and revise an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/or other large carbon-based molecules.		
Science & Engineering Practices: Scientific Knowledge Is Open to Revision in Light of New Evidence	*Disciplinary Core Ideas:* Organization for Matter and Energy Flow in Organisms	*Crosscutting Concepts:* Systems and System Models
Differentiation: *ELL* – Students can work in small groups with bilingual peers to aid in the reading activity. Students can also make use of translation apps if need be. Students can underline words they need help defining and ask the instructor as well. *IEP* – Extended time can be given on the assignment, as well as individualized attention during the small group portion of the lesson. *GATE* – This article (Nature, "*Discovery of DNA Helix: Watson and Crick*") can be given to students who finish early to read and summarize for extra credit.		

Lesson Segment	Materials	Sequence of Lesson	Instructional Strategies	Inclusive Practice to Support All Learners
Anticipatory Set (10 min)	Smartboard, pen, paper	Instructor will start with the topic of DNA in the form of a warm-up. The instructor will ask, "Take 2 minutes and write down everything you know about DNA. Keep in mind things you've learned in previous classes or TV." Then, students will share some of their responses and the teacher will write down common ones on the board, asking probing questions as appropriate.	Some questions could be: "Who discovered DNA?" "Do you think the scientists who discovered DNA had help?" "What is the structure of DNA? How do you know?" "Have you heard of Rosalind Franklin?"	Common responses will be written on the board to help students follow along, guiding questions are asked in order to model behavior

Instruction (20 min)	DNA Discovery article, graphic organizer	Instructor will break students into groups of 3-4 and give them the article and the accompanying graphic organizer. Instructor can explain, "Today we are going to be reading a scientific article about how the structure of DNA was discovered, and filling out a graphic organizer to help with reading the article analytically. We want to be sure to focus on the main idea, or the concept that the article is primarily communicating to us."	Instructor is working to frontload vocabulary related to the reading, which is supportive of ELL students. Activating students prior knowledge of DNA and focusing them on the main idea is helpful in creating shared expectations for the task.	Groups can be mindfully made to ensure bilingual peer presence for ELL students, and to ensure that heterogeneous student groups are represented, information is communicated clearly and expectations are set so the students know what to look for in the article
Guided Practice (14 min)	DNA Discovery article, graphic organizer	Instructor can go through the first paragraph of the article and practice gleaning the important points from the text with the students. Then, the instructor will build a sentence with the class's help about the main idea of the selected paragraph	The instructor models the correct usage of textual evidence and summarization, aiding the students in building connections.	Modeling for students and being clear about each step helps students to follow along, the steps will be clearly written using the SmartBoard or the document camera
Independent Practice (50 min)	DNA Discovery article, graphic organizer, large sticky sheet, post its, markers	Students are to read the rest of the article and fill out the organizer with their thoughts about the main ideas. They can annotate the article or write on it in whatever way is helpful to them. During this period the instructor will walk around and answer/ask any appropriate questions. At the end of the allotted time, the instructor will come by and check that their graphic organizers have been completed. One group will be chosen to share what they thought the main idea was and why, using evidence from the text. The rest of the class will signal whether they agree or disagree	The graphic organizer is designed to aid students in organizing their thinking, and to help in retaining and constructing information gleaned from the article. The four-corners activity helps all students have a chance to respond to a query in a non-threatening way. The post its are also anonymous, meaning that a student may feel more inclined to share their	The graphic organizer and the post-its help to ensure that everyone feels prepared and welcomed to share their thoughts, frontloading necessary vocabulary helps ELL students, instructor monitors the pacing of the activity, small group setting to maximize student learning

		with what was shared. Then, the instructor will take out large sheets of sticky paper and put them at four different tables. The sheets will have these questions: - "Do you think Rosalind Franklin was fairly treated during this scientific process?" - "How has this discovery impacted science, in your opinion?" - "Do you think Watson & Crick should receive all of the credit for this discovery, or should other scientists such as Maurice Wilkins be credited as well?" - "What challenges did Watson & Crick run into during this process?" The students will walk to each of the four stations and record their thoughts on a post it, and put it on the large sheet. They can also respond to other students' post-its with their reactions. They will be required to write at least one post-it and respond at least one time to another student.	thoughts.	
Closure (6 min)	DNA Discovery article, graphic organizer, large sticky sheet, post its, markers	The students at each of the four stations will share the general consensus of the post-its at their sheet, as well as any personal reactions they had. The students will turn in their article and graphic organizer, stapled, as their formative assessment for this unit. The post-it notes also help the instructor to gauge students' thoughts about the article.		Low pressure sharing environment ensures most people feel comfortable to share, student revisions ensures engagement, post-its help the students communicate better with each other and with the instructor

Three English Biochemists Unravel DNA to Unlock the Mystery of Life

By Cynthia Stokes Brown, Big History Project, adapted by Newsela staff on 07.30.16
Word Count **1,225**
Level **1060L**

James Watson and Francis Crick in 1959 Big History Project

In 1953, three English biochemists helped unlock the mystery of life by determining the structure of the DNA molecule. Found in all life on Earth, DNA contains the information by which an organism regenerates its cells and passes traits to its offspring.

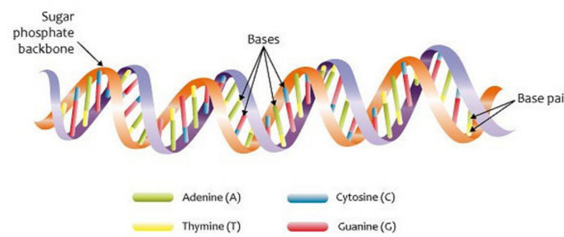
Charles Darwin had successfully proposed the theory of natural selection, but he didn't understand how parents pass characteristics to their offspring. Slight changes when passing down traits made evolution possible.

By the middle of the twentieth century, this was still not well understood. There were major breakthroughs earlier in the century in physics, such as Albert Einstein's Theory of Relativity, and atomic bombs that used nuclear fusion.

After World War II, scientists began trying to understand the physical basis (atomic and molecular) of biology. In the 1950s, biochemists realized that DNA delivered the instructions for copying a new organism. A yard of DNA — deoxyribonucleic acid — is folded and packed into the nucleus of every cell in pairs called "chromosomes."

The parts of DNA

DNA has three parts: a type of sugar called "deoxyribose," a phosphate responsible for its acidity, and four kinds of bases — adenine (A), thymine (T), guanine (G), and cytosine (C).



These four bases seemed too simple to pass on all the information needed to create a new organism. Biochemists didn't understand DNA's structure and how it worked. However, these four bases combine like letters of an alphabet to describe complex variations in genetic traits.

The question became how to study the DNA molecule. Biochemists wanted to understand its structure. They thought this was the key to understanding how it coded the instructions for copying a new organism.

They began taking X-ray images of crystals of DNA, believing that its crystallization meant it must have a regular structure. The pattern of the X-rays bouncing off atoms gave information about their location in the molecule.

One of the pioneers of this technique, called "X-ray crystallography," was Linus Pauling, who worked at the California Institute of Technology, in Pasadena. In the early 1950s, Pauling, a prominent chemist, seemed likely to unlock the mystery of life, since he had already concluded that the general shape of DNA must be a helix, or spiral.

The race is on

The victory, however, went to three people working in England, in one of the great scientific races of all time. One, Rosalind Franklin, was working at the University of London. The other two, James Watson and Francis Crick, were friends and lab mates some 50 miles away at Cambridge University, where they worked cooperatively and shared their ideas.

Franklin was from a wealthy, influential family in London. After earning a PhD from Cambridge in physical chemistry, she began to study DNA at the University of London, in 1951. Franklin became extremely skilled in X-ray crystallography. She was able to produce clear and accurate images of DNA crystals by using fine-focus X-ray equipment and pure DNA samples.

Over at Cambridge, Crick was 35, working on his PhD in the crystallography of proteins. He had grown up in a small English village.

Watson was only 23 in 1951. He had grown up in Chicago, performed on the national radio show "Whiz Kids," entered the University of Chicago at age 15, and secured his doctorate from the University of Indiana at just 22. He was at the Cambridge lab to learn crystallography.

Between 1951 and 1953, Franklin examined her precise X-ray diffraction images. She reasoned that 1) DNA takes two forms (shorter-dryer and longer-wetter), 2) the sugar-phosphate backbones must be on the outside, and 3) the molecule looks the same upside down or right side up.

In late 1952, she recorded an especially clear X-ray image. Her colleague, Maurice Wilkins, showed the image to Watson in 1953 without telling her or asking her permission.

A spiral shape

When Watson saw the image, he knew at once that DNA had to be a helix. He returned to his lab to begin making models out of sheet metal and wire.

Watson and Crick built models to try to visualize DNA. How many strands did the helix have? Which direction did the strands run? Were they on the inside or the outside? How were the four chemical bases arranged?

Franklin believed more X-ray images of better quality would answer the questions. But Watson and Crick knew they were racing against Pauling. They felt making models would speed up the answers.

Using paper models and combining them in different ways, they visualized a structure that solved the puzzle. If two of the bases were bonded in pairs (G with C), they took up the same space as the other pair (A with T). Hence, they could be arranged like steps on a spiral staircase inside of two strands of sugar-phosphates running in opposite directions.

These insights occurred to Crick and Watson in February 1953. They announced at lunch in their usual pub that they had found the secret of life.

The news gets out

The April 25, 1953, issue of *Nature* published Crick and Watson's article, "A Structure for Deoxyribose Nucleic Acid." Wilkins and Franklin, who both accepted Crick and Watson's solution, wrote accompanying articles.

By the 1960s, scientists had accepted the double helix as the structure of DNA. In 1962, Wilkins, Watson, and Crick received the Nobel Prize in medicine/physiology for their work.

Franklin could not share in the prize. She had passed away in 1958 of ovarian cancer. She was just 37. Franklin had a family history of cancer, but her exposure to X-rays may have contributed to her death.

In any case, she may not have had the chance for the award had she been alive. Crick and Watson never told Franklin that they had used her images. In *Nature*, Watson and Crick only mentioned her briefly. She wasn't credited in Watson's book about the discovery, *The Double Helix* (1968).

It wasn't until much later that Watson finally admitted in public that he and Crick could not have found the double helix in 1953 without Franklin's experimental work. If she had survived, would she have been acknowledged and shared in the prize?

In their 1953 article, Watson and Crick did not discuss how DNA copies itself.

Five weeks after their first article in *Nature*, Crick and Watson published another article proposing the idea that, to make a copy, the double helix unzips, or separates, into two strands. Each strand is a backbone of sugar-phosphates with the four bases attached in some sequence.

Then the cell uses each strand as a template to assemble another DNA strand from free-floating complementary bases: A picks up T, while C picks up G. This would result in two identical DNA molecules, one a copy of the other. Occasional mistakes in copying enable evolution to occur and each organism to be unique. This idea has been confirmed, while the means for carrying it out have proved to be quite complex.

Crick continued his research in England until 1976, when he moved to the Salk Institute for Biological Studies in California, where he died in 2004. Watson returned to the United States, researching at Harvard from 1956 to 1976. He helped establish the Human Genome Project in the early 1990s and served as president of the Cold Spring Harbor Laboratory in New York, until his retirement in 2007.

Name: ______________
Period: ______________
Date: ______________

Graphic Organizer for DNA Discovery Article

What (main idea):

Who:	Where:	When:	How:

Why (is this important):

Ms. Webb
Biological Macromolecules Unit

Ms. Webb/9th grade/2019	**Macromolecule Menu Inquiry Lesson**	Mon/Tues/Wed of Week Two in Two Week Macromolecule Unit
Brief Lesson Description: Students construct an informative, organized, and aesthetically pleasing menu that presents the foods they think provide the most nutritious school lunch along with evidence to support their choices.		
Measurable Objective: Students build an argument to justify their choice of food for their school lunch by constructing at least one logically sound claim-evidence-reasoning passage to explain one of their choices.		
Materials: Chromebooks, Macromolecule Menu graphic organizer, pen		
Differentiation Strategies: *ELL* – Photos and diagrams provided to help illustrate the concepts *IEP* – This project is to be completed over three class periods and can be worked on outside of class if extra time is needed. *GATE* – The biochemistry can be delved into further - why do fats and proteins create more sustained energy? Research into how the complexity of the molecule can influence how fast the body breaks it down can be added to the menu.		
Prior Student Knowledge: Four major macromolecules (carbohydrates, proteins, lipids, nucleic acids), metabolism (digestive system breaks polymers into monomers for absorption)		
NGSS Standard: HS-LS1-6. Construct and revise an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/or other large carbon-based molecules.90		
Science & Engineering Practices: Constructing Explanations and Designing Solutions	*Disciplinary Core Ideas:* Organization for Matter and Energy Flow in Organisms	*Crosscutting Concepts:* Energy and Matter
Possible Misconceptions: If something has less calories, does that make it healthier? Not all calories are created equal, as our bodies process different macromolecules differently		
Safety Precautions: None		

Engagement (10 min)

Show images of fruit snacks - do you think this is a healthy snack? Why or why not? What do you think constitutes a healthy snack? What makes something healthy or unhealthy? Introduce energy over time graph and ask students what they think it means for the foods we eat.

Exploration (30 min)

Hand out instructions, students complete the first part of the packer which has them find eight nutrition labels online and transcribe their carbohydrate, protein, and fat content. Students then complete a graphic organizer on macromolecules and nutrition before starting to assemble their school lunch menu.

Explanation (50 min)

Students start making their lunch menu and choosing the foods to include. How will students choose which foods are healthy and should be included in their lunch menu? Question students about their food choices and provide guidance in regards to the energy release graph located in the graphic organizer and how that should influence their menu choices.

Elaboration (50 min)

Students should have arrived at the conclusion that protein and fats provide more sustained energy than carbohydrates, and should make up a decent part of their menu in order to provide students with the needed energy to complete their school day. Students continue to complete their menus and start their claim-evidence-reasoning paragraph about one of the foods that they chose.

Evaluation (10 min)

The accuracy and design of the menu and the claim-evidence-reasoning paragraph will used as the formative assessment for the lesson. The menu can be discussed individually with the student as part of the lesson in order to better inform the student of how they could improve if improvement is needed.

Name: _______________
Period: _______________
Date: _______________

Metabolism, Macromolecules, & the Optimal School Lunch

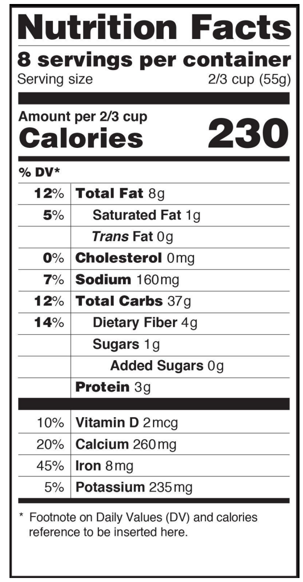
1) What are the four types of biological macromolecules?

   A.

   B.

   C.

   D.



Nutrition Facts
8 servings per container
Serving size 2/3 cup (55g)

Amount per 2/3 cup
Calories 230

% DV*	
12%	**Total Fat** 8g
5%	Saturated Fat 1g
	Trans Fat 0g
0%	**Cholesterol** 0mg
7%	**Sodium** 160mg
12%	**Total Carbs** 37g
14%	Dietary Fiber 4g
	Sugars 1g
	Added Sugars 0g
	Protein 3g
10%	Vitamin D 2mcg
20%	Calcium 260mg
45%	Iron 8mg
5%	Potassium 235mg

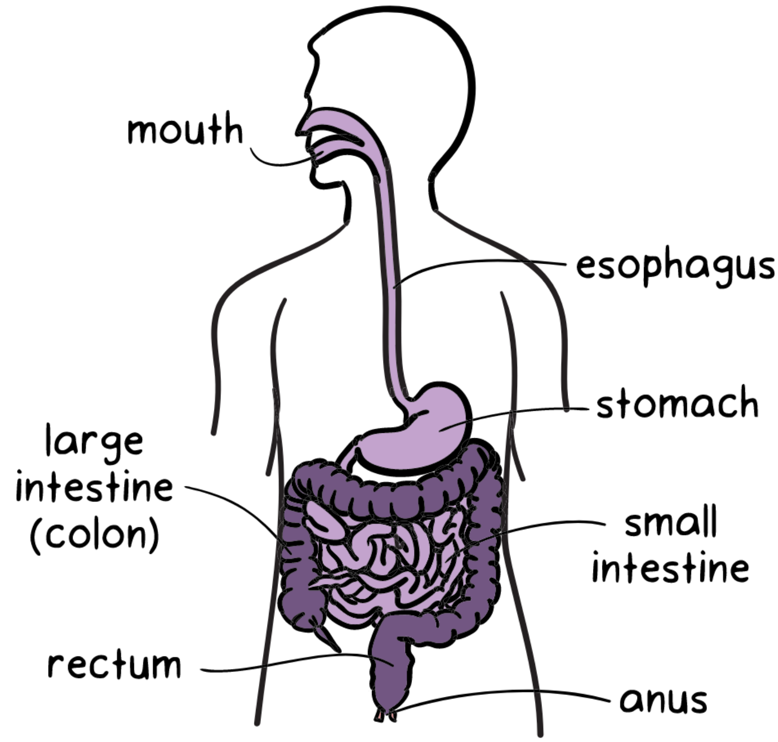
* Footnote on Daily Values (DV) and calories reference to be inserted here.

2) Using the internet, look up the food labels for <u>eight</u> different foods that you would eat.

3) Record in the data table below the total amount in **grams** of <u>fat (lipids)</u>, <u>carbohydrates</u>, and <u>protein</u> in <u>each of the eight foods</u>.

Data table:

Name of Food	Total Carbohydrates	Total Fat	Protein	Total Calories
	g	g	g	cal
	g	g	g	cal
	g	g	g	cal
	g	g	g	cal
	g	g	g	cal
	g	g	g	cal
	g	g	g	cal
	g	g	g	cal



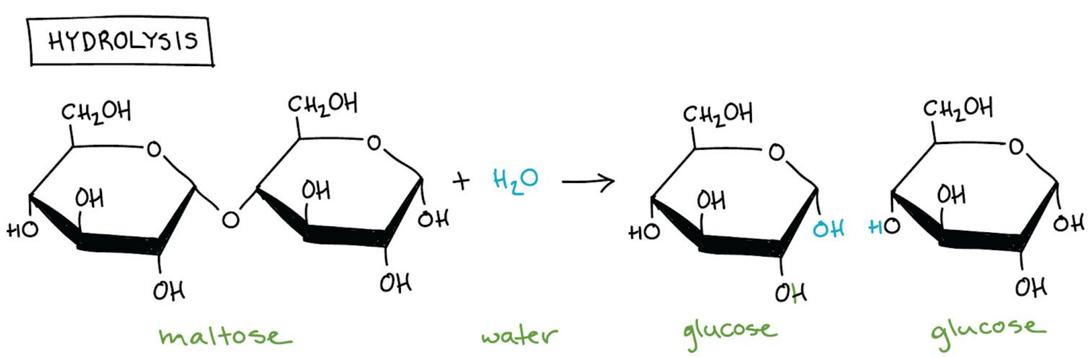
Your digestive system will break down the polymers in the food you eat into smaller molecules called monomers using a process called hydrolysis.

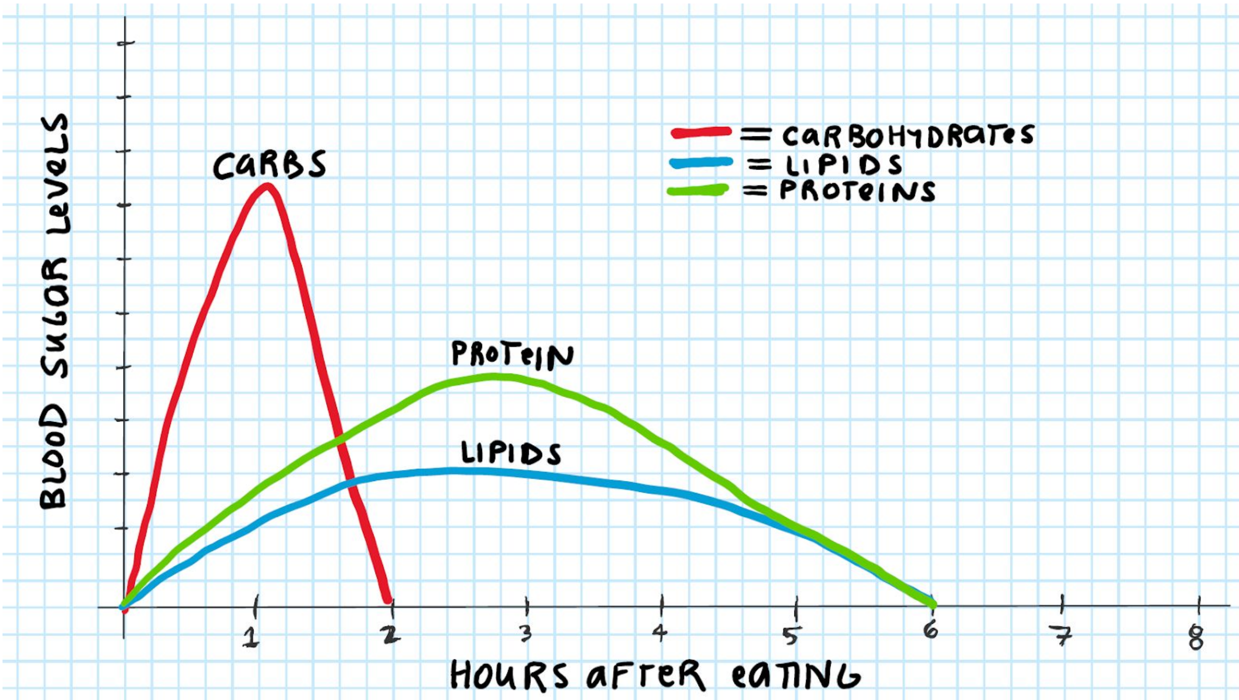
4) What is the monomer of a carbohydrate? ___________________________________

5) What is the monomer of a protein? ____

6) The process of breaking down a larger molecule, called a polymer, into its monomer is called _______________________________ .

7) Draw, circle, and label the diagram below using the following vocab: polymer, monomer





Notice in the graph that both lipids (fats) and proteins can increase blood sugar levels but fat and proteins are not made out of sugars. It makes sense that carbohydrates are broken down into sugars, but not fat or proteins. Your body uses enzymes to convert monomers of proteins (amino acids) into glucose.

8) What type of biomolecule is an enzyme?

____

9) What trends do you notice about carbohydrates in the graph above?

____

____

10) What trends do you notice about proteins and fats in the graph above?

____

____

Fat is an important and necessary energy source for our bodies, but fat can also clog our arteries (blood vessels) and cause a heart attack or stroke if eaten in large quantities over time. The fatty acids and cholesterol can attach to the sides of blood vessels, especially when they are inflamed, and cause a blood clot.

11) In your opinion, what would a healthy meal look like in terms of biological macromolecules? Would it be mostly carbohydrates, proteins, or fats? Would it be a little bit of each? Why?
____
____
____
____

Created by Berkah Icon
from Noun Project

Designing the Optimal School Lunch

You'll have to design a menu that is nutritious and minimizes large fluctuations in blood sugar. You'll fill out the table below with your food's nutrition information, and <u>then design a menu to showcase your choices.</u> *If you eat more than one serving, then you will need to multiply by the number of servings for the grams of carbohydrates, fats, proteins, and calories for that food.*

Type of Food	Carbohydrates	Fats	Proteins	Calories
	g	g	g	cal
	g	g	g	cal
	g	g	g	cal
Number of servings:	Multiply each by the # of servings			
Total	g	g	g	cal

Creating Your Menu Illustration & Justifying Your Choices

Your menu illustration should showcase the food items you picked with some kind of <u>creative representation</u> - it could be a drawing, a picture, or anything else you feel represents the food you chose. It <u>should include information about the food item's macromolecule makeup</u>. You can do this illustration digitally or physically.

12) Write a Claim Evidence Reasoning three sentence paragraph. This paragraph will be about one of the foods you chose above and explain why you chose that food using information from page 4. Fill in the paragraph using the sentence frames.

I claim that ____________________________ would be part of an ideal lunch for school. The evidence to support my claim is that this food has _______ number of grams of ____________ and has _________ number of grams of _______________. The reason why I chose that food is that ____

____

____

____

____.

<table>
<tr><td>Ms. Webb/9th Grade/2019</td><td>Macromolecule Showcase Assessment Direct Instruction Lesson</td><td colspan="2">Thurs/Fri of week 2 in 2 week Biological Macromolecule Unit</td></tr>
<tr><td colspan="4">Brief Lesson Description: After giving an overview of the general information provided in the macromolecule unit and previous lessons, the students will receive instructions to create a poster showcasing the information they’ve gathered. They will work in partners and have two class periods to complete the poster, after which it will be graded in class in small groups.</td></tr>
<tr><td colspan="4">Essential Question: How are structure and function related in biology?</td></tr>
<tr><td colspan="4">Materials: Poster paper, markers/colored pencils, instruction sheet, Chromebooks, pens, glue, scissors</td></tr>
<tr><td colspan="4">NGSS Standard: HS-LS1-6. Construct and revise an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/or other large carbon-based molecules.</td></tr>
<tr><td>Disciplinary Core Content: Organization for Matter and Energy Flow in Organisms</td><td>Crosscutting Concepts: Energy and Matter</td><td colspan="2">Science & Engineering Practices: Developing and Using Models</td></tr>
<tr><td colspan="4">Measurable Objective: Students describe the structure and function of the four major biological macromolecules by designing a poster containing at least two pieces of accurate information about each.
This summative assessment follows each of these four lessons:
● Students argue the validity of their model construction of saturated and unsaturated fatty acids by testing their model against two given structural parameters.
● Students build an argument to justify their choice of food for their school lunch by constructing at least one logically sound claim-evidence-reasoning passage to explain one of their choices.
● Students discuss the context of historical scientific discoveries by reflecting on the discovery of the structure of DNA in a graphic organizer and sharing at least one of their opinions with their classmates in a post-it format.
● Students investigate the effects of substrate concentration and pH on enzyme activity by conducting a virtual experiment using lactase and accurately describing and graphing their findings.</td></tr>
<tr><td colspan="4">Prior Student Knowledge: This lesson serves as the summative assessment for the unit, so students will be familiar with the four major macromolecules (lipids, carbohydrates, proteins, and nucleic acids) and their roles in living organisms.</td></tr>
<tr><td colspan="4">Safety Precautions: None</td></tr>
<tr><td>Anticipatory Set (10 min)</td><td colspan="3"><u>This Kahoot quiz</u> can be given at the start of the class in order to review and formatively assess what students need more practice with before embarking on the poster showcase</td></tr>
</table>

	project. After the quiz, the instructor briefly reviews if any concepts were missed by the majority of the class.
Instructional Input (25 min)	The showcase project is to be introduced after the review, during which the instructor hands out the instructions and rubric. The students can use laptops, their notes, each other, and the instructor as resources for this project. They can work in partners.
Guided Practice (15 min)	After the students get started on their poster projects, the instructor visits each group and checks their progress. They can ask any clarifying questions they need to about the instructions or material. The instructor can differentiate in small groups by explaining concepts in a more interactive way.
Independent Practice (25 min)	As students finish their projects, the instructor checks each one and gives feedback before they submit it for final grading. The instructor refers to the instructions and the rubric to ensure that they've fulfilled the criteria, and asks any questions about aspects of their poster that needs further development. This allows the instructor to facilitate further thinking about portions of their showcase and to help them hone their work.
Evaluation & Closure (25 min)	The instructor calls each group up and grades their showcase according to the rubric in front of them. The instructor asks questions concerning the content of their showcase to ensure they understand the key concepts. Each partner will receive their grade in real time so they can better understand the process and how they can improve if needed.
Differentiation Strategies: *ELL* – EL students can be grouped with a bilingual buddy to help translate instructions if necessary. Visual aids can also be used. *IEP* – Extra time can be given on this assignment, and portions of it can be completed at home. Individual attention can be given by instructor during the course of the project as well. *GATE* – As a challenge question, students can answer "Why do you think lipids do not have true monomers?" in a short summary on their poster for extra credit.	

Name: ______________
Period: ______________
Date: ______________

Macromolecule Showcase

Are you ready to showcase what you've learned about biological macromolecules? Express your learning in a creatively designed poster that must include the following information about each macromolecule:

- Carbohydrates: a labelled diagram of a carbohydrate, which atoms it is primarily made up of, an example of both a polymer and monomer of carbohydrates, an example of a food containing carbohydrates, an example of a function that carbohydrates serve in living organisms, a labelled diagram of two monosaccharides combining to make one disaccharide

- Lipids: a diagram of both a saturated and an unsaturated fatty acid with labels explaining the difference between the two, which atoms they are primarily made up of, an example of foods containing lipids, an example of a function that lipids serve in living organisms

- Proteins: a labelled diagram of a protein, which atoms it is primarily made up of, an example of both a polymer and monomer of proteins, an example of a food containing protein, *two examples* of functions that proteins serve in living organisms, a labelled diagram of two amino acids combining

- Nucleic Acids: a labelled diagram of a nucleic acid that includes the four nitrogenous bases, which atoms are they primarily made up of, a diagram of the structure of DNA, a short summary of the discovery of DNA's structure and who was involved, an example of a function that nucleic acids serve in living organisms

You will have two class periods to complete this poster, and you may work with a partner. You may use your notes, a laptop, your classmates, and me as a resource in creating this showcase poster. It will be graded according to the rubric on the following page.

Macromolecule Showcase Rubric

Category	4	3	2	1	Student Score
Presentation	Student can accurately answer all questions related to facts in the poster and processes used to create the poster.	Student can accurately answer most questions related to facts in the poster and processes used to create the poster.	Student can accurately answer about 75% of questions related to facts in the poster and processes used to create the poster.	Student may need to spend more time familiarizing themselves with the facts presented on the poster.	
Content Accuracy	At least 8 accurate facts are displayed on the poster.	5-7 accurate facts are displayed on the poster.	3-4 accurate facts are displayed on the poster.	Student may need to add more facts onto the poster.	
Required Elements	The poster includes all required elements as well as additional information.	All required elements are included on the poster.	All but 1 of the required elements are included on the poster.	Student may need to revise or add more of the required elements onto the poster.	
Use of Class Time	Used time well during each class period. Focused on getting the project done. Never distracted others.	Used time well during each class period. Usually focused on getting the project done and never distracted others.	Used some of the time well during each class period. There was some focus on getting the project done but occasionally distracted others.	Student may need to reflect on their use of class time and whether it was productive.	